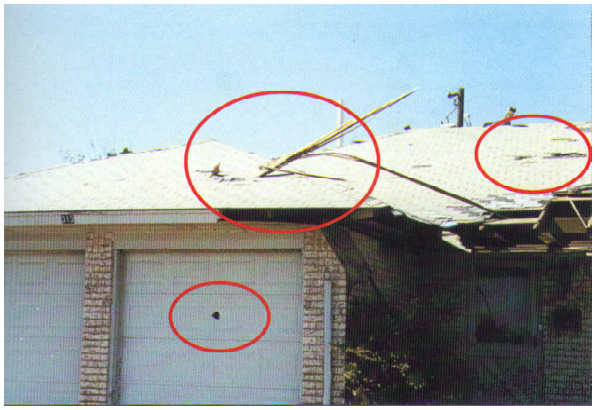
Wind - 201

Reduce potential for flying debris



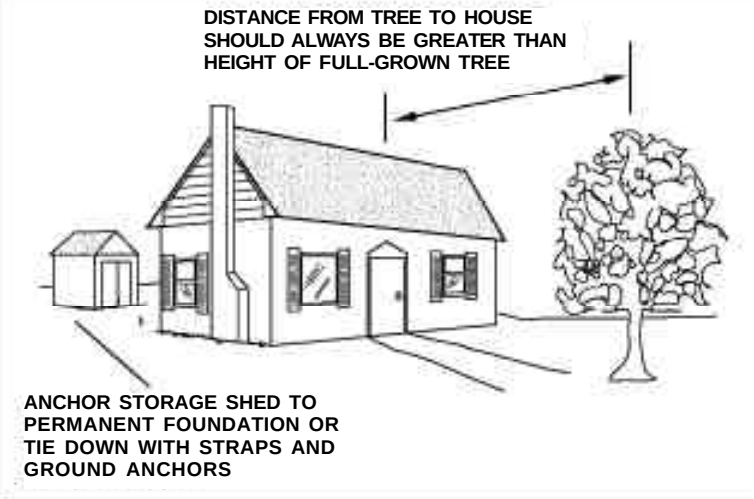
Many parts of the United States are exposed to wind hazards of varying degrees. This threat could be from a tornado, hurricane, or localized winds from canyons or mountains. In some cases, the wind can be strong enough to destroy a home, piece by piece. Winds that pick up debris that strikes your home or car can also be very dangerous. Often the damage is caused by flying debris on or near your property.

Although you cannot accurately predict where and when a strong wind might occur, you can use precautions or mitigation measures that reduce the potential for damage. You should do as much as possible to prevent and reduce your damage, inconvenience, and costs.

Potential Hazard

Outdoor furniture, trees, trash cans, yard debris, outbuildings, or other materials in the immediate vicinity of your home, that can be moved by the wind, are a threat that increases the risk of danger to your home during a hurricane or tornado. The wind can topple trees and tree limbs onto your house. It can also pick up smaller objects and drive them through windows and doors. Another danger is that wind can tear inadequately secured downspouts from your home.

In addition, loose shingles or other building components can fly off and increase the susceptibility of damage to your home. A small breach of the building envelope may lead to severe damage.



Mitigation Measure

You should remove dead and dying trees and potential windborne missiles like outdoor furniture. Also, make sure that all trees are far enough away from your home so that they can't fall on it. That means the distance between your home and any unhealthy tree should always be greater than the height of the tree. Prune dead or dying tree limbs and remove unhealthy large trees, if necessary. You should also clear away any debris, such as fallen tree branches.

All storage sheds and other outbuildings should be securely anchored, either to a permanent foundation or to the ground with straps and ground anchors. The same straps and ground anchors used for manufactured homes also can be used to anchor outbuildings, especially small garden sheds, which are usually not placed on a permanent foundation. Use the same method for home attachments, such as downspouts and TV antennas or dishes. Use strapping to securely fasten them to the home or ground so that they do not detach.

Smaller objects, such as trash cans, barbecue grills, and outdoor furniture, should also be anchored or, if you have adequate warning, moved indoors. You can secure trash cans with cables or chains attached to ground anchors or to wood posts firmly embedded in the ground. Fasten trash can lids to cans with chains or cables.

Notes:

Wind - 202

Anchor the base of your manufactured home

Many parts of the United States are exposed to wind hazards of varying degrees. This threat could be from a tornado, hurricane, or localized winds from canyons or mountains. In some cases, the wind can be strong enough to destroy a home, piece by piece. Winds that pick up debris that strikes your home or car can also be very dangerous. Often the damage is caused by flying debris on or near your property.

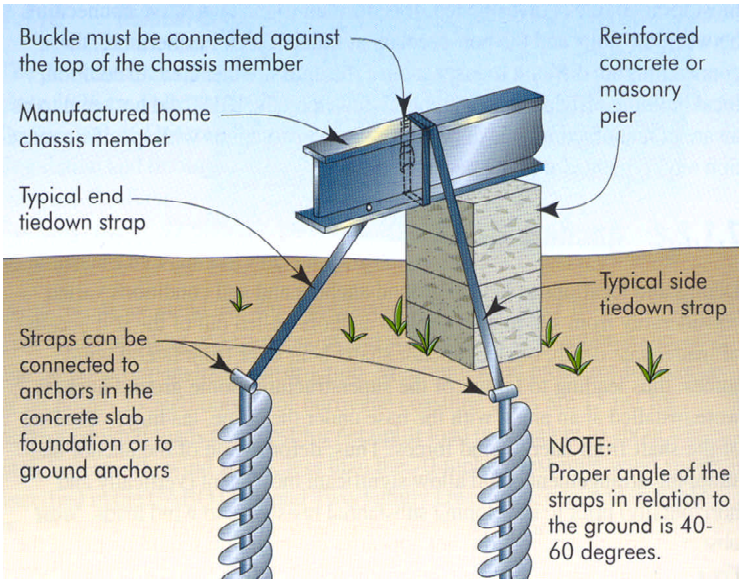
Although you cannot accurately predict where and when a strong wind might occur, you can use precautions or mitigation measures that reduce the potential for damage. You should do as much as possible to prevent and reduce your damage, inconvenience, and costs.

Potential Hazard

During periods of sustained high winds, a manufactured home can easily become dislodged from its foundation and, as a result, even collapse. Besides the obvious structural damage, your interior goods could also be damaged. Homes in coastal areas subject to hurricanes and in inland areas subject to tornadoes are possible candidates for mitigation. Even homes in northern states that typically do not have tornadoes or hurricanes can be subject to strong, straight-line winds that can be just as destructive as a hurricane or tornado.

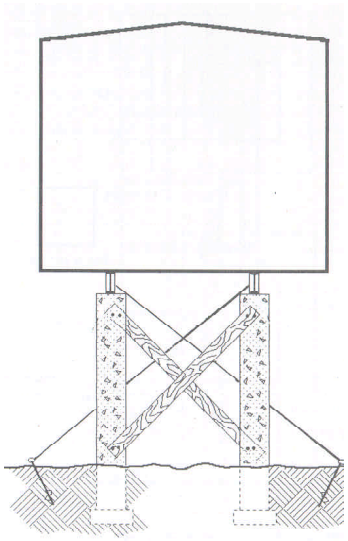
Mitigation Measure

The stability of a manufactured home can be increased by securing it to the ground or a heavy concrete foundation. Before determining the securing strategy, you must have site-specific flood information which may also include the base flood elevation. This information will help you determine how likely or to what depth your immediate area will experience flooding.



A manufactured home can be secured in several ways. You can secure the base directly to the ground or use ties (rust-resistant straps or cables) that go over the top of your home. The ties are held into the ground by anchors whose embedded length and type should be selected for **the applicable soil type. See** *Manufactured Home Installation in Flood Hazard Areas*, FEMA Publication 85, for more information on anchoring tips.

A manufactured home elevated on piers, piles, blocks, stub walls or wood should be braced and anchored appropriately after consideration of the possibility of soil saturation and soil type. There are two common methods of bracing or securing a manufactured home. Knee bracing can be wood crosspieces or wire straps attached to the horizontal beam supporting the home. Diagonal bracing uses wood or steel rods and provides even greater stability. Also, the home should not rest on "dry blocks." Use steel reinforced blocks filled with grout or concrete by temporarily raising or jacking up the home. Then insert reinforcing steel into the concrete masonry units and filled with grout.



A manufactured home that rests on fill material, such as soil, is less likely to catch wind from underneath, but it should be anchored to the foundation by ground anchors.

A typical single family home should be secured to its foundation through its wooden sill or base plate with half-inch diameter anchor bolts spaced at four feet or less and sufficiently embedded.

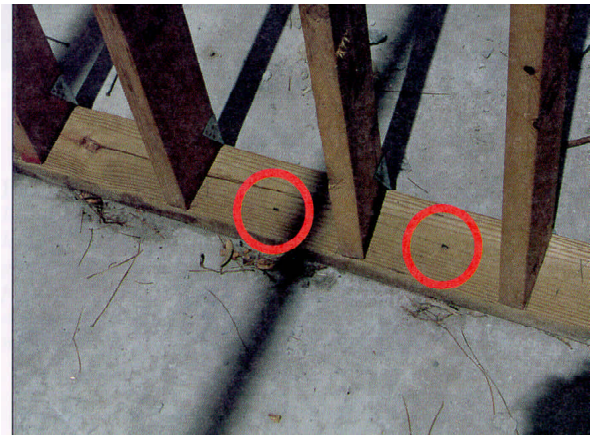
Wind - 203

Bolt your house sill plate connection

Many parts of the United States are exposed to wind hazards of varying degrees. This threat could be from a tornado, hurricane, or localized winds from canyons or mountains. In some cases, the wind can be strong enough to destroy a home, piece by piece. Winds that pick up debris that strikes your home or car can also be very dangerous. Often the damage is caused by flying debris on or near your property.

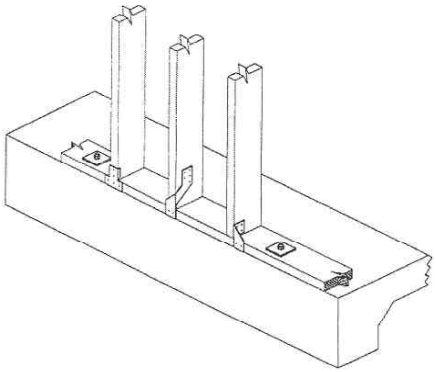
Although you cannot accurately predict where and when a strong wind might occur, you can use precautions or mitigation measures that reduce the potential for damage. You should do as much as possible to prevent and reduce your damage, inconvenience, and costs.

Potential Hazard



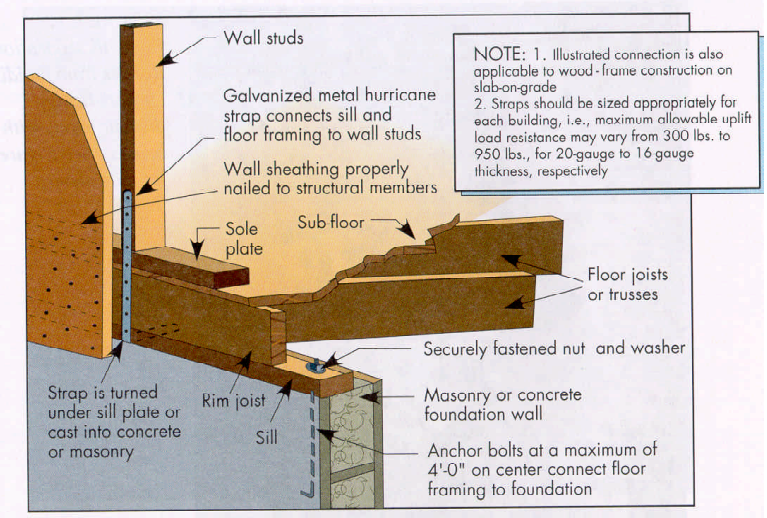
If your home is not adequately anchored to its foundation, it may become dislodged from its foundation from the force of strong winds. If your home is pushed off its foundation, it is more likely to experience structural failure. Many homes have wood framing and lightweight covering materials that can be easily lifted or moved. To make your home more resistant to the lateral and uplift forces of wind, you need to be sure that all parts of your home are firmly interconnected.

Mitigation Measure

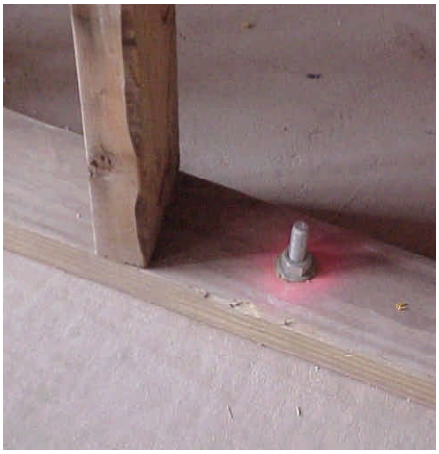


The best protection from these dangers is to secure your home to the ground or a heavy concrete foundation that transfers the lateral and uplift loads from the roof and walls of your home to its foundation.

A typical single family home should be secured to its foundation through its wooden sill or base plate with half-inch diameter anchor bolts no more than four feet apart, according to the manufacturer's installation instructions. The wall studs also should be secured to the base plate and foundation with straps. For existing homes, use concrete anchors to attach the strap to concrete. To properly seat a concrete anchor, which is a special type of screw, a hole must be predrilled into the masonry ¼" deeper than the anchor. The anchor can then be screwed in by using a power drill with a screw bit.



Whether you live in a detached home with a crawl space or a manufactured home, you can secure your home in several ways. You can secure the base directly to the ground or use ties (rust-resistant straps or cables) that go over the top of your home. The ties are held into the ground by anchors whose embedded length and type should be selected for the applicable **soil type. See** *Manufactured Home Installation in Flood Hazard Areas*, FEMA Publication 85, for more information on anchoring.



A manufactured home elevated on piers, piles, blocks, stub walls or wood should be braced and anchored appropriately after consideration of the possibility of soil saturation and soil type. There are two common methods of bracing or securing a manufactured home. Knee bracing can be wood crosspieces or wire straps attached to the horizontal beam supporting the home. Diagonal bracing uses wood or steel rods and provides even greater stability.

Wind - 204

Increase your gable end bracing

Many parts of the United States are exposed to wind hazards of varying degrees. This threat could be from a tornado, hurricane, or localized winds from canyons or mountains. In some cases, the wind can be strong enough to destroy a home, piece by piece. Winds that pick up debris that strikes your home or car can also be very dangerous. Often the damage is caused by flying debris on or near your property.

Although you cannot accurately predict where and when a strong wind might occur, you can use precautions or mitigation measures that reduce the potential for damage. You should do as much as possible to prevent and reduce your damage, inconvenience, and costs.

Potential Hazard

During a windstorm such as a hurricane, homes with gabled roofs are more likely to suffer damage than those without gables. Each end of a gabled roof is shaped like an "A," with the outside walls extending to the peak of the roof. During a strong windstorm, those walls take a beating, so gables that are not properly braced can collapse and cause major damage to the roof.

Gabled roofs are more susceptible to damage by high winds than hip roofs or flat roofs. The wall on a gabled end presents a large surface to the wind and receives its full force. If the framing of the gabled ends and the rest of the roof are not adequately braced to resist the wind, the wall can buckle or fall, and then the roof can fail. Roof failures, especially for unbraced gabled roofs, are a common cause of major damage to homes and their contents in high winds.

Mitigation Measure

If your house has a gabled roof, you should check to see whether the roof framing is braced. After inspecting your roof framing, a building official can tell you whether additional bracing is required.

One methods of gable end bracing consists of 2x4s placed in an "X" pattern from the top center of the gable to the bottom center brace of the fourth truss, and from the bottom center of the gable center to the top center brace of the fourth truss. Use two 3" 14-gauge wood screws or two 16d (16 penny) galvanized common nails to attach the 2x4s to the gable and each of the four trusses. See attached figure for an example of proper bracing.

Notes:

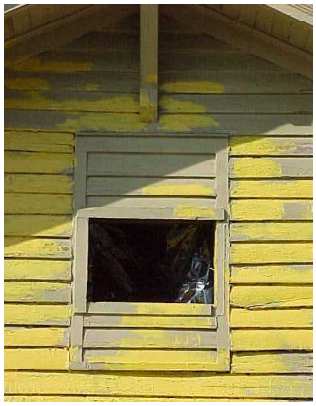
Wind - 205

Replace gable vent with slotted vent

Many parts of the United States are exposed to wind hazards of varying degrees. This threat could be from a tornado, hurricane, or localized winds from canyons or mountains. In some cases, the wind can be strong enough to destroy a home, piece by piece. Winds that pick up debris that strikes your home or car can also be very dangerous. Often the damage is caused by flying debris on or near your property.

Although you cannot accurately predict where and when a strong wind might occur, you can use precautions or mitigation measures that reduce the potential for damage. You should do as much as possible to prevent and reduce your damage, inconvenience, and costs.

Potential Hazard



Wind breaking into your house during a windstorm is particularly hazardous because it can break apart your roof and walls. A small breach of the building envelope may lead to severe damage to your home. Wind and rain coming in also can damage the interior contents of your home.

Mitigation Measure

It is recommended that you provide venting with adequate openings to relieve induced pressures on your roof structure. However, be

sure the venting you install prevents the entry of uncontrolled airflows. Such uncontrolled airflow could result in buildup of induced internal air pressure, which is also dangerous. It is desirable to use a power-operated vent that can be opened during normal weather and closed during storms to prevent uncontrolled winds from entering.

Notes:

Wind - 206

Fasten your roof & walls with hurricane straps

Many parts of the United States are exposed to wind hazards of varying degrees. This threat could be from a tornado, hurricane, or localized winds from canyons or mountains. In some cases, the wind can be strong enough to destroy a home, piece by piece. Winds that pick up debris that strikes your home or car can also be very dangerous. Often the damage is caused by flying debris on or near your property.

Although you cannot accurately predict where and when a strong wind might occur, you can use precautions or mitigation measures that reduce the potential for damage. You should do as much as possible to prevent and reduce your damage, inconvenience, and costs.

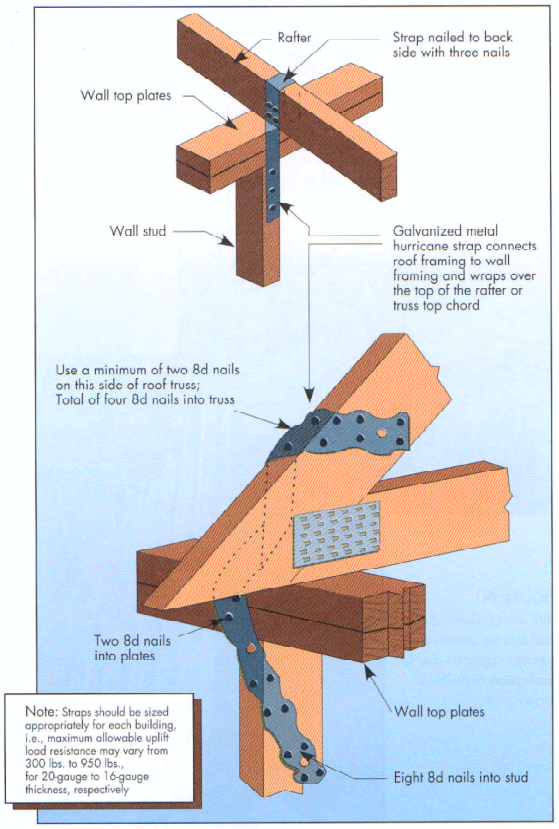
Potential Hazard

During a windstorm, the force of the wind pushes against the outside of your home. That force is passed along from your home's roof to its exterior walls and then to its foundation. Homes can be damaged or destroyed when the energy from the wind is not properly transferred to the ground.

In most homes, gabled roofs are built from manufactured rafters. Sheets of roof sheathing, often plywood, are fastened to the rafters with nails or staples, and roofing material is fastened to the sheathing. In many cases, the rafters are held in place only by the plywood on top. This arrangement may not be enough to hold the roof on your home during a strong windstorm like a hurricane.

Mitigation Measure

To improve the connection between your home's roof and its walls and foundation and thus reduce the risk of losing your roof to high winds, you should install hurricane straps or clips. Hurricane straps or clips will help hold any type of roof to the walls. Inspect your attic for hurricane straps or clips of galvanized metal.



To install hurricane straps or clips, remove the roof sheathing around the edge of the roof to reveal the horizontal underside of the eave. Also remove the exterior covering to reveal the top 12" to 18" of the wall. If the exterior covering is brick veneer, you may need to remove small sections of brick.

If your roof has trusses, make sure you tie them to the wall either by anchoring them to the top plate and then the top plate to the wall stud, or strapping the truss directly to the wall stud. You can anchor the roof to the top of the wall of wood or masonry homes with straps or connectors.

Similarly, for two-story buildings, the upper story should be secured to the lower floor level. Use at least four 8d nails to secure the galvanized floor tie anchors to each of the top floor studs, floor joists or trusses, wall top plate, and first floor wall studs. To secure the straps or clips to wood, use a minimum of two 8d nails on either side of the truss for a total of four 8d nails. In addition, use two 8d nails to secure the strap or clip to the spine of the truss, if possible. Use two 8d nails to secure the strap or clip to the wall top plates. Use eight 8d nails to secure the strap or clip to the wall stud.

If you need to connect the strap or clip to masonry, you can use concrete anchors, which are screws designed for concrete embedment. Predrill holes for the anchors ¼" deeper than the anchor to allow for dust from predrilling. Concrete anchors ¼" in diameter and 2 ¼" or 2 ¾" long should be sufficient. Power tools are recommended for seating the screw.

Wind - 207

Improve the securing of your roof sheathing

Many parts of the United States are exposed to wind hazards of varying degrees. This threat could be from a tornado, hurricane, or localized winds from canyons or mountains. In some cases, the wind can be strong enough to destroy a home, piece by piece. Winds that pick up debris that strikes your home or car can also be very dangerous. Often the damage is caused by flying debris on or near your property.

Although you cannot accurately predict where and when a strong wind might occur, you can use precautions or mitigation measures that reduce the potential for damage. You should do as much as possible to prevent and reduce your damage, inconvenience, and costs.

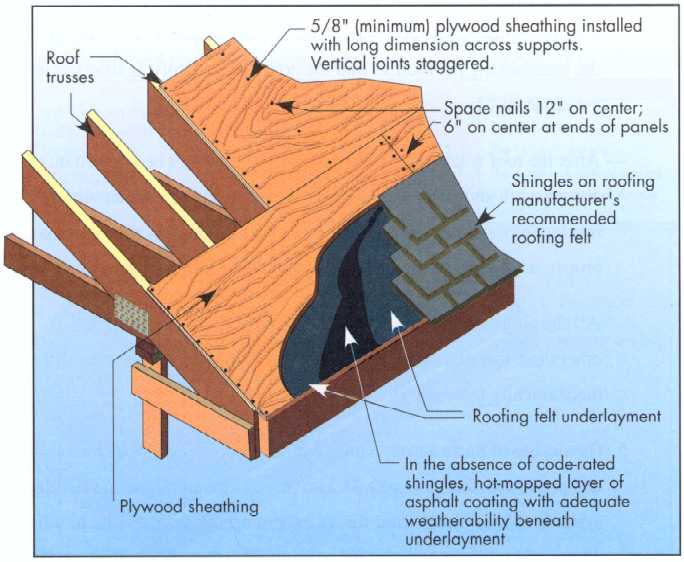
Potential Hazard

During a windstorm, the force of the wind pushing against the outside of your home is very strong. Roof systems are particularly vulnerable to strong winds because they are elevated and thus, very exposed. The force from the wind is passed from your roof to the exterior walls and then to the foundation. Homes can be damaged or destroyed when the energy from the wind is not properly transferred to the ground.

In most homes, gabled roofs are built using manufactured rafters. Sheets of roof sheathing, often plywood, may not be enough to hold the roof on your home during a strong windstorm like a hurricane.

Mitigation Measure

Roof sheathing can be reinforced from underneath without removing a roof that is in good condition. You can fasten the brackets into place with screws, nails, or a high-strength adhesive. Make sure the screws or nails do not puncture or pass through the plywood sheathing. If you use a high-strength adhesive, you may need to insert a shim to create a little space where you can shoot the glue. Be sure the high-strength adhesive you choose has the product approval code AFG01, which will appear on its packaging; that is your assurance that the product is suitable for this purpose.

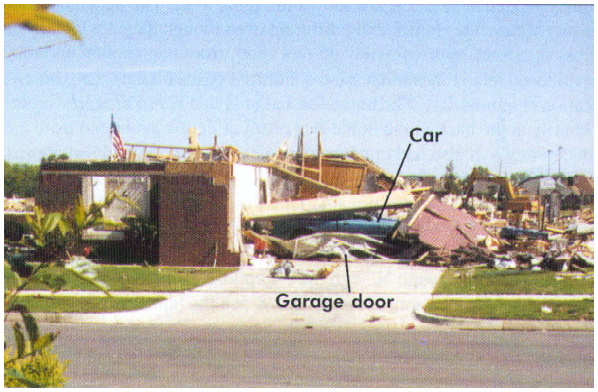


If your roof is being replaced, use plywood sheets that are at least 5/8" thick. They should be oriented so that the long dimension goes across the supports (not parallel to them). Also, the vertical joints should be staggered. The spacing of nails along the border of the plywood panels should be 6" on center. Spacing in non-border areas should be 12" on center. Use screws rather than smooth-bodied or even ridged nails because they are less likely to be pulled out.

Notes:

Wind - 208

Improve closure of your windows and doors

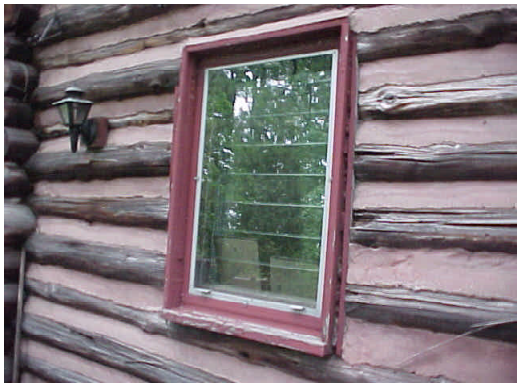


Many parts of the United States are exposed to wind hazards of varying degrees. This threat could be from a tornado, hurricane, or localized winds from canyons or mountains. In some cases, the wind can be strong enough to destroy a home, piece by piece. Winds that pick up debris that strikes your home or car can also be very dangerous. Often the damage is caused by flying debris on or near your property.

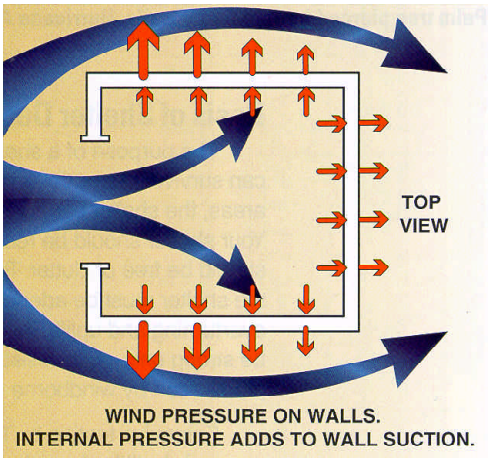
Although you cannot accurately predict where and when a strong wind might occur, you can use precautions or mitigation measures that reduce the potential for damage. You should do as much as possible to prevent and reduce your damage, inconvenience, and costs.

Potential Hazard

Strong wind events can cause damage for many reasons. The outside walls, doors, and windows are the protective shell of your home. If that protective shell is broken, high winds can enter, put pressure on your home's roof and walls, and push them apart. Also, the wind can carry heavy objects and debris, which can then become deadly missiles. In hurricanes and tornadoes, pressure differences between the inside and outside of your home can cause windows to shatter and break. Rain which heavy winds drive through a broken window into your home can be a major cause of damaged household goods. Shards of broken glass could also cause painful and severe injury or death to you and your family.

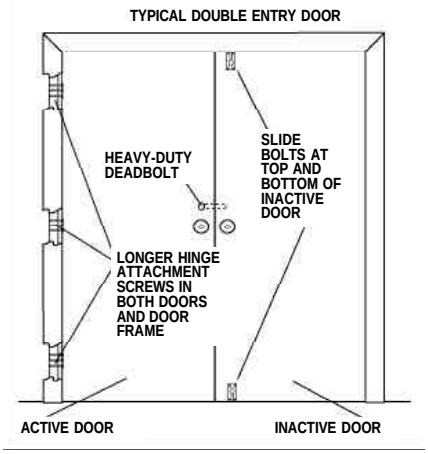


A common misunderstanding is that windows should be left open to equalize and stabilize pressure on your home. The truth is that if hurricane winds enter any opening, damage is much more likely to occur because of the increased internal pressure on walls and roof supports.



Mitigation Measure

You can protect your home by strengthening its doors and windows. Make sure all windows, doors, and openings are fitted with bolts and impact resistant materials. Adding slide bolts and dead bolts to your windows and doors will also increase your family's general security. Safety window film will hold glass shards in place, thereby reducing potential injuries, deaths and property loss from flying glass. If you use tinted safety glass, you will increase the energy efficiency of your home by reducing the effect of solar heat in summer and retaining heat in winter. You can add tinting to a window or door that already has safety glass.



Replacement of your windows and sliding doors is probably most beneficial in coastal areas where the threat from high winds occurs regularly. However, inland areas also frequently experience strong winds. If your home is in a high-risk area from strong winds and a window or door needs replacing because it does not close properly, it may be beneficial to replace it with one that is impact-resistant. Because the impact-resistant products are relatively new, you should consider replacing only standard-size windows and sliding glass doors.

Notes:

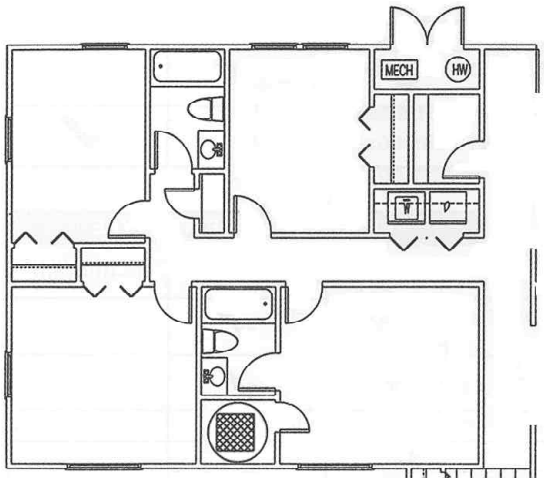
Wind - 209

Create a safe area in your home

Many parts of the United States are exposed to wind hazards of varying degrees. This threat could be from a tornado, hurricane, or localized winds from canyons or mountains. In some cases, the wind can be strong enough to destroy a home, piece by piece. Winds that pick up debris that strikes your home or car can also be very dangerous. Often the damage is caused by flying debris on or near your property.

Although you cannot accurately predict where and when a strong wind might occur, you can use precautions or mitigation measures that reduce the potential for damage. You should do as much as possible to prevent and reduce your damage, inconvenience, and costs.

Potential Hazard



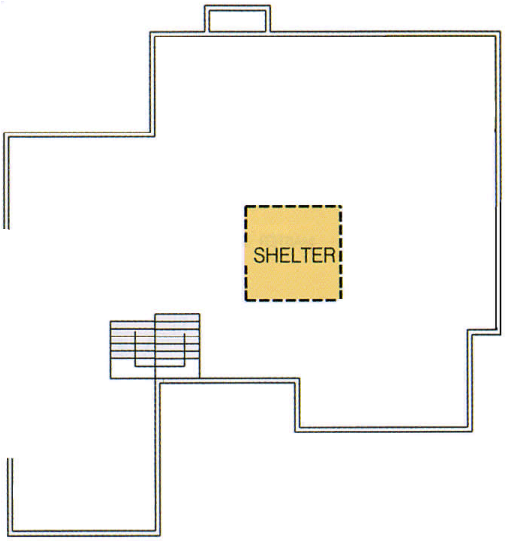
Mitigation measures can help reduce damage to property caused by extreme winds. However, even after you apply mitigation measures, you still face risks to life and property. Modern technology has provided warning of hurricanes early enough so that coastal areas can be evacuated before storms arrive. Unfortunately, hurricanes also can travel far inland and cause great damage. With tornadoes, nor'easters, and straight-line winds, though, there often is little warning. However, you can reduce the number of lives lost by protecting yourself and your loved ones inside your home.

Mitigation Measure

Residents of tornado and hurricane-prone areas can build a "safe room" or in-residence shelter as protection against deadly tornadoes and hurricanes. A safe room, or in-residence shelter, is a small windowless room, such as a closet or bathroom, readily accessible from all parts of the house, designed to provide protection for your family. Its purpose is threefold - to save lives, reduce injuries, and relieve anxiety.

The safe room is appropriate for both existing residences and newly constructed homes. *Taking Shelter from the Storm: Building a Safe Room Inside Your House*, FEMA Publication 320, outlines a room shelter design, including construction plans, materials, and cost estimates. One free copy of this document is available to each homeowner by calling 1-800-480-2520. The publication was developed by FEMA with Texas Tech University's Wind Engineering Research Center, Lubbock, Texas.

Research from inspections of homes in more than 90 towns and cities which were struck by tornadoes revealed that, in most cases, small rooms in the central portion of the house remained standing even when the rest of the house was severely damaged or completely destroyed. This realization led to the conclusion that these interior rooms could be reinforced to provide a high degree of occupant protection at a reasonable cost. A shelter built according to the FEMA Pub. 320 plans can provide protection against winds of up to 250 miles per hour and flying objects traveling at 100 miles per hour.



If you live in an area where there are tornadoes and hurricanes, consider constructing a safe room in your home. Remember: mitigate now–before the next windstorm–to save lives later.

Wind - 210

Improve the bracing of your “A” frame roof

Many parts of the United States are exposed to wind hazards of varying degrees. This threat could be from a tornado, hurricane, or localized winds from canyons or mountains. In some cases, the wind can be strong enough to destroy a home, piece by piece. Winds that pick up debris that strikes your home or car can also be very dangerous. Often the damage is caused by flying debris on or near your property.

Although you cannot accurately predict where and when a strong wind might occur, you can use precautions or mitigation measures that reduce the potential for damage. You should do as much as possible to prevent and reduce your damage, inconvenience, and costs.

Potential Hazard

Because the roof is the highest point of a home, it will likely suffer great stresses and loads from windstorms, like hurricanes, tornadoes, straight-line winds, and nor’easters. Keeping the roof on your home is the first, and maybe most important, step in weathering the storm. If your roof comes off or fails partially, damage to your interior contents is almost a certainty.

To see what sort of bracing your roof’s rafters have, go into your attic. If the attic does not have a floor, be careful to walk only on the wood joists. Also, notice how the plywood is attached to the rafter system

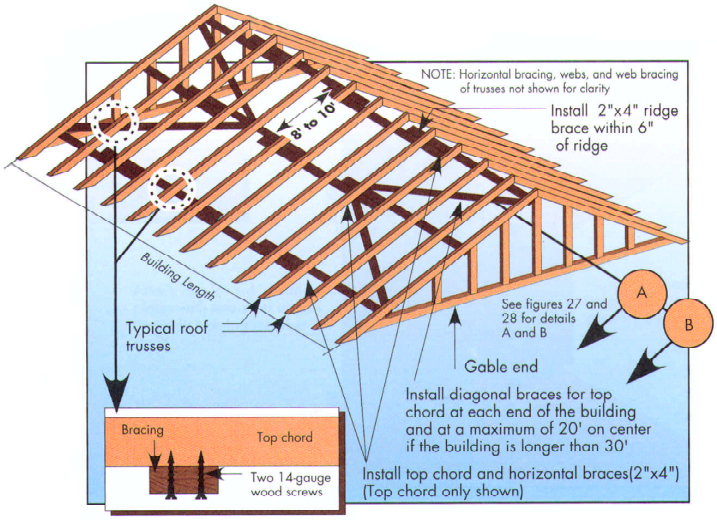
For an A-frame roof, sheets of roof sheathing, often plywood, are fastened to the rafters with nails or staples, and roofing

material is fastened to the sheathing. If most of the large nails or staples coming through the sheathing have missed the rafters, consider having the sheathing properly installed. (See Fact Sheet 207.)

In many cases, the rafters are held in place only by the plywood on top. This arrangement may not be enough to hold the roof in place during a strong windstorm like a hurricane. Installing additional bracing makes your roof's rafter system stronger.

Mitigation Measure

If your house has a gabled roof, you should check to see whether the roof framing is braced. If you are unsure whether your gabled roof is adequately braced, make a quick inspection. If you do not see any wood perpendicular to the rafters, then they have no bracing at all. The guidelines below indicate the minimum bracing needed.



In gabled roofs, bracing usually runs the length of the roof. If you do not have bracing, it should be installed. You can do this yourself or hire a professional. Install 2x4s the length of your roof, overlapping the ends of the 2x4s across two trusses. (See Figure.) Braces should be installed 18" from the ridge, in the center span, and at the base, with eight to ten feet between the braces. Use two 3-inch, 14-gauge wood screws or two 16d (16 penny) galvanized common nails at each rafter. Because space in attics is generally limited, screws may be easier to install. Always use screws that are at least two inches long and install them in pairs to be sure the connection is secure.

Notes:

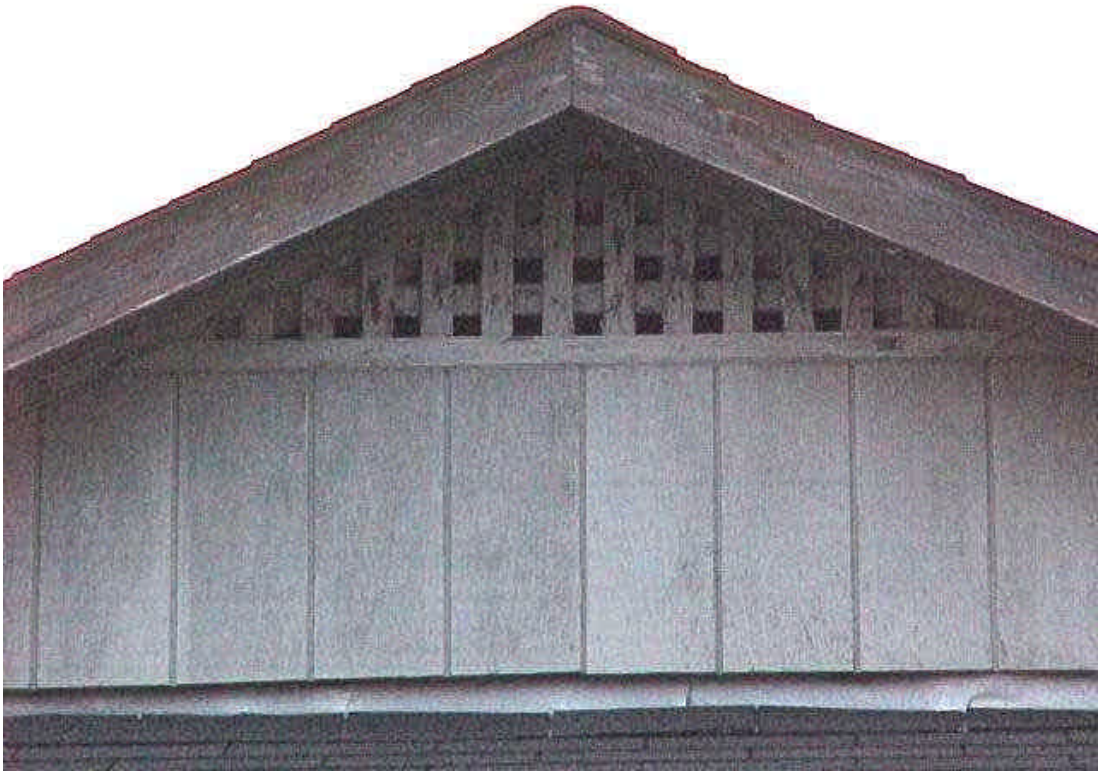
Notes	**Wind Exercise Sheet**
Assess Wind Risk	Participants look at pictures of potential risks and identify the appropriate mitigation measures by putting the corresponding numbers from the Action Checklist on the answer sheet.

Wind Answer Sheet	
Picture Number	**Action Checklist Number**
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Verify Mastery	Discuss responses.

Wind Risk No. 1

Wind Risk No. 2



Wind Risk No. 3

Wind Risk No. 4

Wind Risk No. 5

Wind Risk No. 6

Wind Risk No. 7

Wind Risk No. 8

Wind Risk No. 9

Wind Risk No. 10

	Wind Exercise Sheet Answer Key
	The answers below are only possible, not definite. Encourage participants to identify potential hidden risks that may necessarily be visible in the photo.

Wind Answer Sheet	
Picture Number	**Action Checklist Number**
1	204, 206, 207, 210
2	204, 205, 206, 207, 210
3	201, 206, 207
4	201, 202, 208
5	201
6	201, 202
7	201, 206, 208
8	201, 202, 208
9	201, 202
10	210, 206